

(51)Int.Cl. <sup>7</sup>	識別記号	F I	テ-マ-ト(参考)
C 2 3 C 16/50		C 2 3 C 16/50	B 2 H 0 9 0
16/44		16/44	D 4 K 0 3 0
G 0 2 F 1/1333	5 0 5	G 0 2 F 1/1333	5 0 5 5 F 0 4 5
H 0 1 L 21/205		H 0 1 L 21/205	

審査請求 未請求 請求項の数6 OL (全 9 頁)

(21)出願番号 特願平11-157692

(22)出願日 平成11年6月4日(1999. 6. 4)

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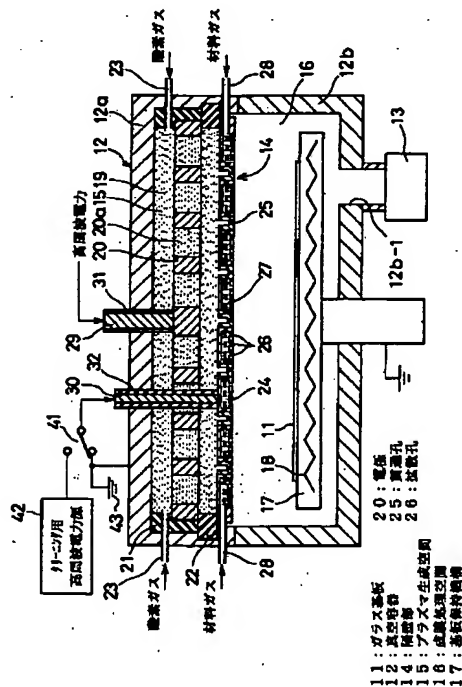
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(54)【発明の名称】 CVD装置

(57)【要約】

【課題】 大面積基板にCVDによりシラン等を用いてシリコン酸化膜等を成膜する場合、パーティクルの発生を抑制し、基板へのイオン入射を防止する。

【解決手段】 真空容器12内でプラズマを生成してラジカルを発生させ、このラジカルとシラン等で基板に成膜処理を行うCVD装置である。真空容器内にその内部をプラズマ生成空間15と成膜処理空間16の二室に隔離する隔壁部14が設けられる。隔壁部には複数の貫通孔25と拡散孔26が形成されている。内部空間24にはシラン等が供給され、シラン等は拡散孔を通して成膜処理空間に導入される。プラズマ生成空間で生成されたラジカルは、貫通孔を通して成膜処理空間に導入される。貫通孔は、孔内でのガス流速を $u$ 、実質的な孔の長さを $L$ 、相互ガス拡散係数を $D$ とすると、 $uL/D > 1$ の条件を満たす。



## 【特許請求の範囲】

【請求項1】 真空容器内でプラズマを生成して活性種を発生させ、この活性種と材料ガスで基板に成膜を行うCVD装置において、

前記真空容器の内部を二室に隔離する導電性隔壁部を前記真空容器内に設け、前記二室のうち、一方の室の内部は高周波電極が配置されたプラズマ生成空間として形成され、他方の室の内部は前記基板を搭載する基板保持機構が配置された成膜処理空間として形成され、さらに前記隔壁部には前記プラズマ生成空間と前記成膜処理空間を通じさせる複数の貫通孔が形成され、

前記貫通孔は、孔内でのガス流速を $u$ 、実質的な孔の長さを $L$ 、相互ガス拡散係数を $D$ とすると、 $uL/D > 1$ の条件を満たし、

前記隔壁部は、さらに、前記プラズマ生成空間から隔離されかつ前記成膜処理空間と複数の拡散孔を介して通じている内部空間を有し、この内部空間には外部から前記材料ガスが供給され、前記内部空間に供給された前記材料ガスは複数の前記拡散孔を通して前記成膜処理空間に導入され、

前記高周波電極に高周波電力を与えて前記プラズマ生成空間でプラズマ放電を発生させることにより前記プラズマ生成空間で生成された前記活性種は、前記隔壁部に形成された複数の前記貫通孔を通して前記成膜処理空間に導入されることを特徴とするCVD装置。

【請求項2】 前記拡散孔は、孔内でのガス流速を $u$ 、実質的な孔の長さを $L$ 、相互ガス拡散係数を $D$ とすると、 $uL/D > 1$ の条件を満たす状態で、前記活性種を前記成膜処理空間に導入することを特徴とする請求項1記載のCVD装置。

【請求項3】 前記隔壁部には、その内部空間で前記材料ガスを均一に拡散する少なくとも二層の拡散構造が設けられることを特徴とする請求項1または2記載のCVD装置。

【請求項4】 前記隔壁部はクリーニング用高周波電力を供給する高周波給電部に接続され、前記隔壁部に適時に高周波電力を供給して前記成膜処理空間でクリーニング用プラズマを生成することを特徴とする請求項1～3のいずれか1項に記載のCVD装置。

【請求項5】 前記高周波電極は前記プラズマ生成空間を形成する前記室の中央に配置され、前記高周波電極と、前記高周波電極の周囲を囲む電極としての前記真空容器の一部および前記隔壁部との間でプラズマ放電を発生させることを特徴とする請求項1～3のいずれか1項に記載のCVD装置。

【請求項6】 前記高周波電極を前記プラズマ生成空間の上側位置に設け、前記高周波電極と前記隔壁部との間でプラズマ放電を発生させることを特徴とする請求項1～3のいずれか1項に記載のCVD装置。

## 【発明の詳細な説明】

## 【0001】

【発明の属する技術分野】本発明はCVD装置に関し、特に、大型のフラットパネル基板への成膜に適したCVD装置に関するものである。

## 【0002】

【従来の技術】大型の液晶ディスプレイの作製方法として、従来、高温ポリシリコン型TFT（薄膜トランジスタ）を利用するものと、低温ポリシリコン型TFTを利用するものとが知られている。高温ポリシリコン型TFTを利用する作製方法では、高品質な酸化膜を得るために、1000℃以上の高温に耐える石英基板が使用されていた。これに対して低温ポリシリコン型TFTの作製においては、通常のTFT用ガラス基板を使用するため、低温環境（例えば400℃）で成膜を行う必要がある。低温ポリシリコン型TFTを利用して液晶ディスプレイを製作する方法は、特別な基板を使用する必要がなく、成膜条件の設定が簡単であるという利点を有し、近年実用化され、その生産量は拡大しつつある。

【0003】低温ポリシリコン型TFTを利用する液晶ディスプレイの作製で、低温でゲート絶縁膜として適当なシリコン酸化膜を成膜する場合、プラズマCVDが使用される。このプラズマCVDでシリコン酸化膜を成膜する際、代表的な材料ガスとしてはシラン、テトラエトキシシラン（TEOS）などが使用される。

【0004】材料ガスとしてシラン等を使用しプラズマによるCVDでシリコン酸化膜を成膜する場合、従来のプラズマCVD装置によれば、基板の前面空間に材料ガスと酸素などを導入し、材料ガスと酸素の混合ガスでプラズマを生成し、当該プラズマに対して基板を晒すことにより、当該基板の表面上にシリコン酸化膜を形成するようにしていた。このように従来のプラズマCVD装置では、材料ガスは、プラズマCVD装置内に生成されたプラズマ中に直接的に供給するように構成されていた。このため、従来のプラズマCVD装置の構成によれば、基板の前面空間に存在するプラズマから基板の成膜面に対して高エネルギーのイオンが入射し、シリコン酸化膜にダメージを与え、膜特性が悪化するという問題が存在した。さらにプラズマ中に材料ガスが直接的に導入されるため、材料ガスとプラズマが激しく反応してパーティクルが発生し、これによって歩留まりが低下するという問題もあった。

【0005】そこで従来では、上記問題を解決するため、一例として、遠隔プラズマ方式を利用したプラズマ処理装置が提案されていた。遠隔プラズマ方式では、プラズマ装置内のプラズマ生成領域から離れた、寿命の短い荷電粒子が消滅し、比較的寿命の長いラジカルが卓越して存在する領域に基板を配置し、かつ材料ガスが基板の配置領域の近くに供給されるように構成している。プラズマ領域で生成されたラジカルは、基板が配置された領域の方向へ拡散し、基板の表面の前面空間に供給され

る。かかる遠隔プラズマ方式のプラズマ処理装置によれば、材料ガスとプラズマの激しい反応が抑制され、パーティクルの発生量が低減され、さらにイオンの基板への入射も制限されるという利点を有している。

【0006】また従来では、特開平6-260434号公報（特許第2601127号）によってプラズマCVD装置が提案されていた。このプラズマCVD装置は、平行平板電極構造を有し、高周波電極と基板ホルダ電極の間に中間電極を配置して高周波電極と基板ホルダ電極の間の空間を仕切りかつ高周波電極と中間電極の間のみに高周波電力を供給することによって高周波電極・中間電極間のみにプラズマ放電を発生させ、プラズマ放電で発生した励起活性種とイオンを中間電極に形成された貫通孔を通して基板の前面空間に導入するように構成されている。高周波電極は従来のシャワーヘッド形式の電極であり、多数の孔を有する拡散板の各孔を通してプラズマ生成用ガスをプラズマ生成空間に導入している。また原料ガスは、ガス導入管、中間電極に形成されたガス導入空間およびガス噴出口を通して基板の前面空間に導入されている。このプラズマCVD装置では、高周波電極と基板ホルダ電極の間の空間が中間電極によって仕切られ、高周波電極と中間電極の間の空間のみにプラズマ生成空間として形成され、プラズマ生成領域が基板が置かれた場所から離れた構成を有している。このプラズマCVD装置は、平行平板電極構造を有した遠隔プラズマ方式の装置の変形例ということができる。

【0007】また従来、特開平5-21393号公報に開示されるプラズマCVD装置が存在する。このCVD装置では、平行平板型のCVD装置を形成する真空容器の内部にプラズマ発生室と基板処理室を作り、その境界部にメッシュプレートを設置した構成を示している。

【0008】さらに従来では、特開平8-167596号公報に開示されるプラズマ処理装置が存在する。このプラズマ処理装置では、金属製メッシュプレートとその支持部材によって、真空容器において、プラズマ生成室とプラズマ処理室とを空間的に分離して形成している。このプラズマ処理装置によれば、メッシュプレートに形成された複数の開口部の直径を、プラズマ生成室で生成したプラズマのデバイ長の2倍以下にすることにより、プラズマ中の荷電粒子を遮蔽し、被処理物に対して電気的に中性の励起原子種等を照射させるようにしている。

【0009】

【発明が解決しようとする課題】前述の遠隔プラズマ方式のプラズマ処理装置の場合には、プラズマ生成領域と基板配置領域が接続空間を介し離れて形成され、基板から離れた所で生成されたラジカルを接続空間を通してその拡散作用で基板の表面へ供給するようにしたため、成膜速度が低くなり、基板の表面近傍でのラジカルが悪くなるという問題があった。特に、基板の表面近傍でのラジカルが悪いため、大型液晶ディスプレイ

に用いられる大面積の基板に対応することができないという問題が提起された。

【0010】特開平6-260434号公報（特許第2601127号）に開示されたプラズマCVD装置によれば、高周波電極と中間電極の間のプラズマ生成空間に材料ガスが供給されないことから、高周波電極の周辺で化学反応が起こらず、高周波電極での膜の堆積がなく、さらにパーティクルの発生が生じないという利点が主張されている。しかしながら、厳密に検討すると、中間電極に形成された貫通孔のサイズに関して特別な考慮はなく、材料ガスがプラズマ生成空間へ逆拡散する可能性がある。従って、材料ガスが、中間電極の上側に入り込む可能性があり、高周波電極の周辺で化学反応が起こるおそれがある。

【0011】特開平5-21393号公報に開示されるプラズマCVD装置による場合にも、メッシュプレートに形成された貫通孔のサイズは本発明の条件を満たさないように決められ、材料ガスがプラズマ生成空間へ逆拡散する可能性があり、前述と同様な問題が起きる。

【0012】特開平8-167596号公報に開示されるプラズマ処理装置の場合、プラズマ生成室からプラズマ処理室への荷電粒子の移動を妨げる構造を有している。しかしながら、プラズマに触れないようにプラズマ処理室へ導入された材料ガスが、メッシュプレートの複数の開口部を通してプラズマ生成室へ逆拡散することを防ぐ構造は開示されていない。従って、材料ガスがメッシュプレートを通してプラズマ生成室へ入り込む可能性があり、プラズマと材料ガスが反応するおそれがある。

【0013】本発明の目的は、上記の問題を解決することにより、低温ポリシリコン型TFTを利用した大型液晶ディスプレイの作製等で、プラズマを利用するCVDに基づきシラン等の材料ガスを用いてシリコン酸化膜等を大面積基板に成膜する場合に、成膜を行う前の段階でのプラズマと材料ガスとの接触を装置構造の上で可能な限りなくし、パーティクルの発生を十分に抑制し、また基板表面へのイオン入射を防止し、さらに基板の成膜面近傍でのラジカルを良好にし、大面積基板への成膜に有効に利用できるCVD装置を提供することにある。

【0014】

【課題を解決するための手段および作用】本発明に係るCVD装置は上記目的を達成するため次のように構成される。

【0015】このCVD装置は、真空容器内でプラズマを生成して活性種（ラジカル）を発生させ、この活性種と材料ガスで基板に成膜処理を行う装置である。真空容器には、真空容器の内部を二室に隔離する導電性の隔壁部が設けられる。これらの2室のうち、一方の室の内部は高周波電極が配置されたプラズマ生成空間として形成され、他方の室の内部は基板を搭載する基板保持機構が

ス流量を500sccm、成膜処理空間16の圧力を100Paとすると、上記式の値は11となる。このような場合には、シランガスの拡散に比較して流れの影響が十分に大きいので、プラズマ生成空間15へのシランガスが拡散することは少なくなる。

【0039】上記のようにプラズマ生成空間15と成膜処理空間16は、上記特性を有する貫通孔25と拡散孔26が多数形成された隔壁部14でそれぞれ閉じられた室となるように仕切られて隔離されているため、成膜処理空間16に直接導入されたシランと酸素プラズマが接触することはほとんどない。従って、従来装置のごとく、シランと酸素プラズマが激しく反応することが防止される。

【0040】次に成膜処理空間16のクリーニングについて説明する。本実施形態のCVD装置によれば、成膜処理空間16内にプラズマが十分に拡散してこないで、成膜処理空間16に対してクリーニングを行うことが困難であるという問題を生じる。そこで、前述のごとく電力導入棒30を隔壁部14に電気的に接続し、切替スイッチ41をクリーニング用高周波電力源42側に接続し、クリーニング用高周波電力源42から高周波電力を供給することにより成膜処理空間16内に例えばNF<sub>3</sub>プラズマを生成するようにした。生成されたプラズマで成膜処理空間16の内部をクリーニングする。またクリーニング速度を問題にしない場合は、成膜処理空間16での放電を行わず、プラズマ生成空間15にNF<sub>3</sub>プラズマを生成し、隔壁部14の貫通孔25を通して成膜処理空間16に拡散したフッ素ラジカルを利用してクリーニングを行うこともできる。その際、切替スイッチ41を接地端子43に接続し、隔壁部14を接地電位とする。かかるクリーニングを行うタイミングは、予め決められた所定時間ごと、あるいは所定の基板枚数ごと等の基準に基づいて適時に行われる。

【0041】次に図3を参照して本発明に係るCVD装置の第2の実施形態を説明する。図3において、図1で説明した要素と実質的に同一の要素には同一の符号を付し、ここで詳細な説明を反復することは省略する。本実施形態の特徴的構成は、上容器12aの天井部の内側に円板状絶縁部材33を設け、かつその下側に電極20を配置するようにした。電極20には上記孔20aは形成されず、一枚状の板の形態を有する。電極20と隔壁部14によって平行平板型電極構造によるプラズマ生成空間15を形成する。その他の構成は第1実施形態の構成と実質的に同じである。さらに、第2実施形態によるCVD装置による作用、効果も前述の第1実施形態と同じである。

【0042】前述の実施形態では、材料ガスとしてシランの例を説明したが、これに限定されず、TEOS等の他の材料ガスを用いることができるのは勿論である。またシリコン酸化膜のみならず、シリコン窒化膜等その他

の成膜にも応用することができる。本発明の原理的考えは、材料ガスがプラズマに接することによりパーティクルが発生すること、基板ヘイオンが入射することが問題となるすべての処理に応用でき、成膜、表面処理、等方エッチング等に応用できる。さらに前述の実施形態では、隔壁部は二重構造になっているが、必要に応じて多層構造にできるのは勿論である。

#### 【0043】

【発明の効果】以上の説明で明らかなように本発明によれば、大面積基板にプラズマCVDによりシラン等の材料ガスを用いてシリコン酸化膜等を成膜する場合に、所定条件を満たす複数の貫通孔あるいは拡散孔が形成された隔壁部を設けることによって真空容器の内部をプラズマ生成空間と成膜処理空間に隔離し、プラズマ生成空間で生成された活性種は隔壁部の貫通孔を通して成膜処理空間に導入され、材料ガスは隔壁部の内部空間および拡散孔を通してプラズマに触れることなく直接に成膜処理空間に導入するようにしたため、材料ガスとプラズマとの間の激しい化学反応を防止でき、その結果、パーティクルの発生を抑制し、基板へのイオン入射を防止することができる。

【0044】また材料ガスを均一に導入でき、かつ隔壁部に形成された複数の貫通孔によって酸素ガスのラジカルも成膜処理空間に均一に供給でき、これによって基板の表面近傍でのラジカルとシラン等の分布を良好にし、大面積基板への成膜を有効に行うことができる。

【0045】また隔壁部にクリーニング用電力導入棒を付設し、電力を供給してクリーニングを行えるようにしたため、真空容器内に隔壁部で隔離されたプラズマ生成空間と成膜処理空間を形成したとしても、成膜処理空間の清浄度を適切に維持することができる。

#### 【図面の簡単な説明】

【図1】 本発明の第1実施形態の構成を示す縦断面図である。

【図2】 隔壁部に形成された各種の孔の拡大断面図である。

【図3】 本発明の第2実施形態の構成を示す縦断面図である。

#### 【符号の説明】

11	ガラス基板
12	真空容器
14	隔壁部
15	プラズマ生成空間
16	成膜処理空間
17	基板保持機構
20	電極
24	内部空間
25	貫通孔
26	拡散孔
27	均一板

配置された成膜処理空間として形成される。さらにこの隔壁部にはプラズマ生成空間と成膜処理空間を通じさせる複数の貫通孔が形成される。隔壁部は、さらに、プラズマ生成空間と隔離されかつ成膜処理空間と複数の拡散孔を介して通じている内部空間を有する。この内部空間には外部から材料ガスが供給され、内部空間に供給された材料ガスは複数の拡散孔を通して上記成膜処理空間に導入される。プラズマ生成空間で生成された活性種は、隔壁部に形成された複数の貫通孔を通して成膜処理空間に導入される。上記の貫通孔あるいは拡散孔の大きさ（長さおよび径等）は下記のごとく特定の条件を満たすように設計される。

【0016】上記CVD装置において、隔壁部に形成された複数の貫通孔は、孔内でのガス流速を $u$ 、実質的な孔の長さを $L$ 、相互ガス拡散係数（孔の両側の2種のガスの相互ガス拡散係数）を $D$ とすると、 $uL/D > 1$ の条件を満たす。また隔壁部の下壁に形成された複数の拡散孔についても上記と同じ条件を満たすように形成されることが好ましい。

【0017】隔壁部に形成された貫通孔等が満たす上記条件としては、これらの孔を通して、プラズマ生成空間のガスが物質移動流れとして、材料ガスが拡散により、それぞれ反対側に移動することを想定するとき、拡散による移動量が制限されるように設定される。

【0018】上記のCVD装置において、好ましくは、隔壁部には、その内部空間に、材料ガスを均一に拡散する少なくとも二層の拡散構造が設けられる。

【0019】上記のCVD装置では、酸素ガスを利用してプラズマを生成しシラン等の材料ガスを用いて基板の表面に膜を堆積する構成において、処理室である真空容器の内部空間を、隔壁部で隔離することによって、プラズマを生成する空間と成膜処理空間とに分離し、成膜処理空間に配置された基板の処理表面がプラズマに晒されない構成が採用される。また隔壁部によって隔離されていることから、成膜処理空間に導入された材料ガスがプラズマ生成空間側に移動することが十分に制限される。実際、隔壁部には複数の貫通孔が形成されているので、隔壁部の両側のプラズマ生成空間と成膜処理空間は貫通孔を通してつながっているが、貫通孔の大きさは前述のごとき条件を満たすように形成されているので、成膜処理空間に導入された材料ガスがプラズマ生成空間側に逆拡散するのが防止される。

【0020】基板の成膜では、プラズマ生成空間で酸素ガスでプラズマを生成し、プラズマで発生したラジカル（酸素ガスの活性種）と、材料ガスであるシラン等を、基板が配置された成膜処理空間に導いて、CVDの作用によって基板の表面に膜をつける。膜の例としては、低温ポリシリコン型TFTを利用する液晶ディスプレイの作製では低温でゲート絶縁膜として作られるシリコン酸化膜である。複数の貫通孔と拡散孔を有する隔壁部を設

けることによって、真空容器の内部空間はプラズマ生成空間と成膜処理空間に隔離され、隔壁部内に形成された内部空間と上記拡散孔を利用してシラン等を、プラズマが生成される領域を避けて、基板前面の成膜処理空間に直接に導入すると共に、プラズマ生成空間で生成されたラジカルを隔壁部に形成された上記貫通孔を通して成膜処理空間に導入するようにした。さらに上記の貫通孔のサイズを上記の特定条件を満たすように設定することによって、シラン等の材料ガスがプラズマ生成空間側に拡散するのを可能な限り防止し、シラン等がプラズマに触れるのを防いでいる。これにより、シラン等とプラズマが直接的に混合されるのを防止でき、従来の不具合を解消する。

【0021】上記のCVD装置において、隔壁部はクリーニング用高周波電力を供給する高周波給電部に接続され、隔壁部に適時に高周波電力を供給して成膜処理空間でクリーニング用プラズマを生成することとを特徴とする。上記のCVD装置において、高周波電極はプラズマ生成空間を形成する室のほぼ中央に配置され、高周波電極と真空容器上面の間、および高周波電極と隔壁部の間で、プラズマが生成されるように構成されている。この構成によって、真空容器の一部と導電性の隔壁部を電極として利用することにより、隔壁部の貫通孔を除いて、生成されたプラズマを密閉することができるプラズマ生成室を作ることができる。上記のCVD装置において、高周波電極をプラズマ生成空間の上側位置に設け、高周波電極と隔壁部との間でプラズマ放電を発生させるように構成することもできる。これは電極構造の変形例であり、隔壁部を利用して、隔壁部の貫通孔を除いて密閉されたプラズマ生成室を作ることができる。

【0022】

【発明の実施の形態】以下に、本発明の好適な実施形態を添付図面に基づいて説明する。

【0023】図1と図2を参照して本発明に係るCVD装置の第1の実施形態を説明する。図1において、このCVD装置では、好ましくはシランを材料ガスとして使用し、通常のTFT用ガラス基板11の上面にシリコン酸化膜をゲート絶縁膜として成膜する。CVD装置の容器12は、成膜処理を行う際、排気機構13によってその内部が所望の真空状態に保持される真空容器である。排気機構13は真空容器12に形成された排気ポート12b-1に接続されている。

【0024】真空容器12の内部には、水平な状態で導電性部材で作られた隔壁部14が設けられており、平面形状が例えば円形の隔壁部14は、その周縁部が環状の絶縁部材22の下面に押さえ付けられて密閉状態を形成するように配置されている。真空容器12の内部は隔壁部14によって上下の2つの室に隔離される。上側の室はプラズマ生成空間15を形成し、下側の室は成膜処理空間16を形成する。隔壁部14は、所望の特定の厚み

を有し、かつ全体的に平板状の形態を有し、さらに真空容器12の水平断面形状に類似した平面形状を有する。隔壁部14には内部空間24が形成されている。

【0025】上記ガラス基板11は、成膜処理空間16に設けられた基板保持機構17の上に配置されている。ガラス基板11は隔壁部14に実質的に平行であって、その成膜面(上面)が隔壁部14の下面に対向するように配置されている。基板保持機構17の電位は真空容器12と同じ電位である接地電位に保持される。さらに基板保持機構17の内部にはヒータ18が設けられている。このヒータ18によってガラス基板11の温度は所定の温度に保持される。

【0026】真空容器12の構造を説明する。真空容器12は、その組立て性を良好にする観点から、プラズマ生成空間15を形成する上容器12aと、成膜処理空間16を形成する下容器12bとから構成される。上容器12aと下容器12bを組み合わせて真空容器12を作るとき、両者の間の位置に隔壁部14が設けられる。隔壁部14は、その周縁部が、後述するごとく電極20を設けるときに上容器12aとの間に介設される環状絶縁部材21、22のうちの下側の絶縁部材22に接触するようにして取り付けられる。これによって、隔壁部14の上側と下側に、隔離されたプラズマ生成空間15と成膜処理空間16が形成される。隔壁部14と上容器12aとによってプラズマ生成空間15が形成される。プラズマ生成空間15においてプラズマ19が生成されている領域は、前述の隔壁部14と上容器12aとほぼ中央位置に配置される板状の電極(高周波電極)20とから形成されている。電極20には複数の孔20aが形成されている。隔壁部14と電極20は、上容器12aの側部内面に沿って設けられた2つの環状絶縁部材21、22によって支持され、固定される。環状絶縁部材21には、外側からプラズマ生成空間15へ酸素ガスを導入する導入パイプ23が設けられている。導入パイプ23は流量制御を行うマスフローコントローラ(図示せず)を介して酸素ガス供給源(図示せず)に接続されている。

【0027】真空容器12の内部は、隔壁部14によってプラズマ生成空間15と成膜処理空間16に隔離されるが、隔壁部14には所定条件を満たす複数の貫通孔25が内部空間24を貫通する状態で分散して形成されており、これらの貫通孔25を介してのみプラズマ生成空間15と成膜処理空間16はつながっている。また隔壁部14内に形成された内部空間24は、材料ガスを分散させて均一に成膜処理空間16に供給するための空間である。さらに隔壁部14の下壁には材料ガスを成膜処理空間16に供給する複数の拡散孔26が形成されている。上記の貫通孔25または拡散孔26はそれぞれ後述する所定の条件を満たすように作られている。また上記内部空間24には、材料ガスを導入するための導入パイ

プ28が接続されている。導入パイプ28は側方から接続されるように配置されている。また内部空間24の中には、材料ガスが拡散孔26から均一に供給されるように、複数の孔27aを有するように穿孔された均一板27がほぼ水平に設けられている。図2に示すごとく、均一板27によって隔壁部14の内部空間24は上下の2つの空間部分24a、24bに分けられている。導入パイプ28で内部空間24に導入される材料ガスは、上側の空間24aに導入され、均一板27の孔27aを通過して下側の空間24bに至り、さらに拡散孔26を通過して成膜処理空間16に拡散されることになる。以上の構造に基づいて、成膜処理空間16の全体にわたって材料ガスを均一に供給することが可能となる。

【0028】図2では隔壁部14の一部が拡大して示され、貫通孔25と拡散孔26と均一板27の要部が拡大して示される。貫通孔25は、一例として、プラズマ生成空間15側が大きな径を有し、成膜処理空間16の側が絞られ、小さい径で作られている。

【0029】上容器12aの天井部には、電極20に接続された電力導入棒29と、隔壁部14に接続された電力導入棒30とが設けられている。電力導入棒29によって電極20に放電用高周波電力が給電される。電極20は高周波電極として機能する。電力導入棒30の外端部は切替スイッチ41を介してクリーニング用高周波電源42または接地端子43に接続される。プラズマにより成膜を行うときには切替スイッチ41は接地端子43に接続されて隔壁部14は接地電位に保持される。また後述するごとく適時のタイミングで切替スイッチ41をクリーニング用高周波電源42に接続し、隔壁部14に対してクリーニング用高周波電力を給電し、クリーニングを行う。なお接地端子43は真空容器12の上容器12aにも接続され、上容器12aも接地電位に保持されている。電力導入棒29、30は、いずれも絶縁物31、32で被われており、他の金属部分との絶縁が図られている。

【0030】上記のように構成されたCVD装置による成膜方法を説明する。図示しない搬送ロボットによってガラス基板11が真空容器12の内部に搬入され、基板保持機構17の上に配置される。真空容器12の内部は、排気機構13によって排気され、減圧されて所定の真空状態に保持される。次に、導入パイプ23を通して酸素ガスが真空容器12のプラズマ生成空間15に導入される。このとき酸素ガスの流量は外部のマスフローコントローラで制御される。式(1)、(2)を用いて、酸素ガスの流量( $Q_{O_2}$ )と圧力( $P_{O_2}$ )、および温度( $T$ )から酸素の流速( $u$ )が求められる。

【0031】

【数1】

$$Q_{O_2} = \rho_{O_2} u A \quad (1)$$

$$P_{O_2} = \frac{\rho_{O_2} R T}{M} \quad (2)$$

ここで、 $\rho_{O_2}$  : 酸素ガスの密度

$M$  : 酸素分子量

$R$  : 普遍ガス定数

$T$  : 絶対温度で表わした隔壁部14の温度

$A$  : 隔壁部14に形成された貫通孔25の総断面積

$u$  : 貫通孔25を流れる酸素ガスの流速

【0032】一方、材料ガスである例えばシランが導入パイプ28を通して隔壁部14の内部空間24に導入される。シランは、最初に内部空間24の上側部分24aに導入され、均一板27で均一化されて下側部分24bに移動し、次に拡散孔26を通して成膜処理空間16に直接に、すなわちプラズマに接触することなく導入される。成膜処理空間16に設けられた基板保持機構17は、ヒータ18に通電が行われているため、予め所定温度に保持されている。

【0033】上記の状態、電極20に対して電力導入棒29を介して高周波電力が供給される。この高周波電力によって放電が生じ、プラズマ生成空間15内において電極20の周囲に酸素プラズマ19が生成される。酸素プラズマ19を生成することで、中性の励起種であるラジカル（励起活性種）が生成される。

【0034】基板11の表面に成膜を行うとき、真空容器12の内部空間は、導電材料で形成された隔壁部14でプラズマ生成空間15と成膜処理空間16に隔離された構成において、プラズマ生成空間15では酸素ガスを導入しかつ電極20に高周波電力を供給して酸素プラズマ19を生成し、他方、成膜処理空間16では材料ガスであるシランが隔壁部14の内部空間24および拡散孔26を通して直接に導入される。プラズマ生成空間15で生成された酸素プラズマ19のうち長寿命を持つ中性ラジカルが隔壁部14の複数の貫通孔25を通して成膜処理空間16に導入されるが、荷電粒子の多くは死滅する。シランは隔壁部14の内部空間24および拡散孔26を通して成膜処理空間16に直接に導入される。また成膜処理空間16に直接に導入されたシランは、貫通孔25の有する形態に基づきプラズマ生成空間の側に逆拡散することが抑制される。このように、材料ガスであるシランを成膜処理空間16に導入するとき、シランが直接に酸素プラズマ19に触れることはなく、シランと酸素プラズマとが激しく反応することが防止される。かくして、成膜処理空間16において、隔壁部14の下面に

$$\rho_{SiH_4} u_{SiH_4} = -D_{SiH_4-O_2} \text{grad} \rho_{SiH_4} \quad (3)$$

$$\rho_{SiH_4} u_{SiH_4} \approx -D_{SiH_4-O_2} \rho_{SiH_4} / L \quad (4)$$

【0038】次に具体的な例を説明する。隔壁部14の温度を300℃、隔壁部14に形成された貫通孔25の

対向して配置された基板11の表面にシリコン酸化膜が成膜される。

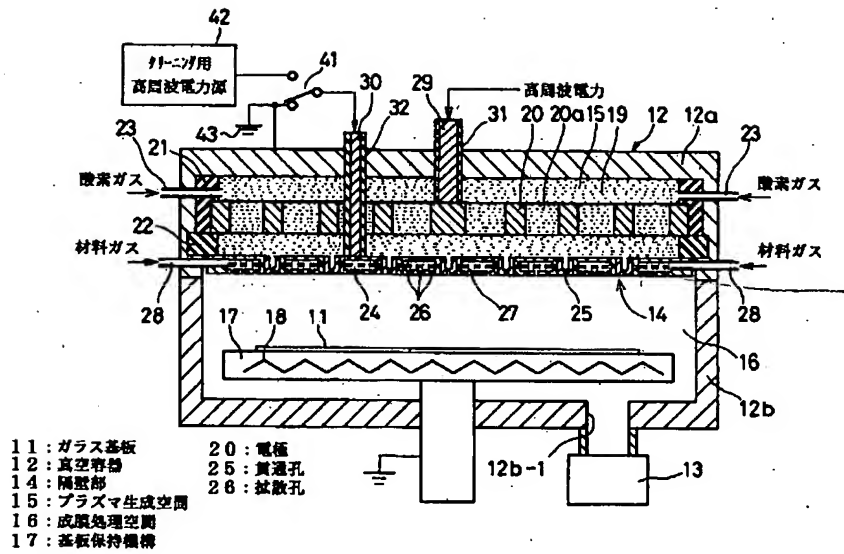
【0035】上記の構造において、隔壁部14の複数の貫通孔25の大きさ等の形態は、プラズマ生成空間15における酸素ガスを貫通孔中の物質移動流れとし、成膜処理空間16におけるシランが、貫通孔25を通して反対側の空間に拡散移動を行うことを想定するとき、その拡散による移動量を所望範囲に制限するように決められている。すなわち、例えば、隔壁部14の温度がTであるときの貫通孔25を流れる酸素ガスとシランに関してその相互ガス拡散係数をDとし、かつ貫通孔25の最小径部分の長さ（貫通孔の特徴的長さ）をLとすると、ガス流速（ガスの流速uとする）を用いて、 $uL/D > 1$ の関係が満たされるように決められる。以上の貫通孔の形態に関する条件は、好ましくは、隔壁部14に形成された拡散孔26に関しても同様に適用される。

【0036】上記 $uL/D > 1$ の関係は次のように導き出される。例えば貫通孔25を移動する酸素とシランの関係に関しシランガス密度（ $\rho_{SiH_4}$ ）と拡散流速（ $u_{SiH_4}$ ）と相互ガス拡散係数（ $D_{SiH_4-O_2}$ ）を用いて下記の式（3）が成立する。貫通孔の特徴的長さをLとすると、式（3）が式（4）に近似できる。式（4）の両辺を比較した結果、シランの拡散流速（ $u_{SiH_4}$ ）が $-D_{SiH_4-O_2}/L$ で表わされる。従って、上記の式（1）と（2）から得られる酸素流速をuとし、シランの拡散流速を $-D_{SiH_4-O_2}/L$ とした場合に、これらの2つの流速の絶対値の比、すなわち $| -u / (-D_{SiH_4-O_2}/L) | = uL/D_{SiH_4-O_2}$ の値は酸素物質移動速度とシラン拡散速度の比であり、この比 $uL/D_{SiH_4-O_2}$ を1以上にすることは、拡散の流量に比較して対流による流量が大きいかを意味する。すなわち、 $uL/D_{SiH_4-O_2}$ の値を1以上にすることは、シランの拡散影響が小さいことを意味している。

【0037】

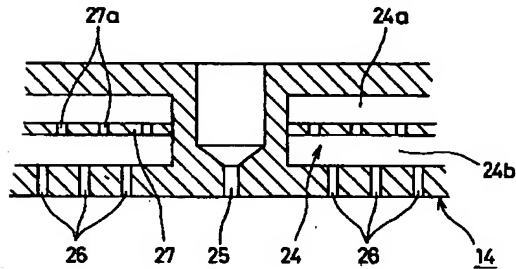
直径0.5mm、直径0.5mmの部分の長さ（L）を3mm、貫通孔25の総数を500個、酸素ガスのガ

【図1】

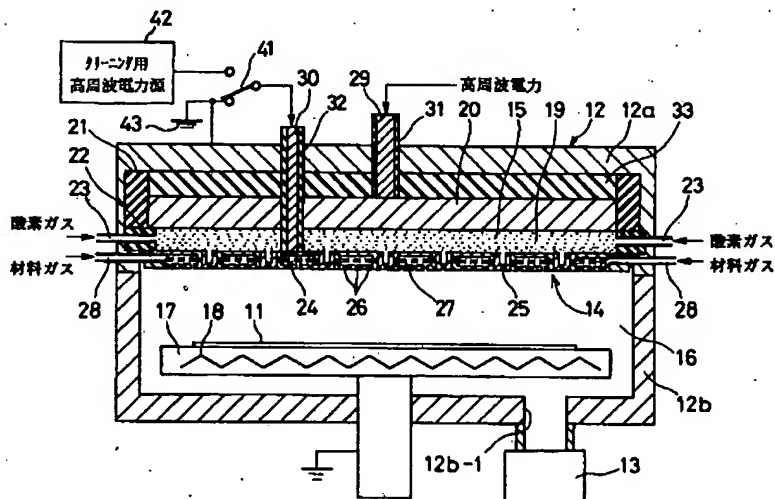


barrier  
wall

【図2】



【図3】



フロントページの続き

F ターム(参考) 2H090 HB03X HC03 HC18  
4K030 AA06 AA14 BA44 CA06 CA17  
DA06 EA05 EA06 FA03 JA01  
JA12 KA08 KA17 KA30 LA18  
5F045 AA08 AA16 AB32 AB33 AC01  
AC02 AC07 AC11 AE19 AF07  
BB15 BB16 CA15 DP03 EB02  
EB05 EE20 EF14 EH18

## PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2000-345349

(43)Date of publication of application : 12.12.2000 ↓

(51)Int.Cl.

C23C 16/50  
C23C 16/44  
G02F 1/1333  
H01L 21/205

(21)Application number : 11-157692

(71)Applicant : ANELVA CORP.

(22)Date of filing : 04.06.1999

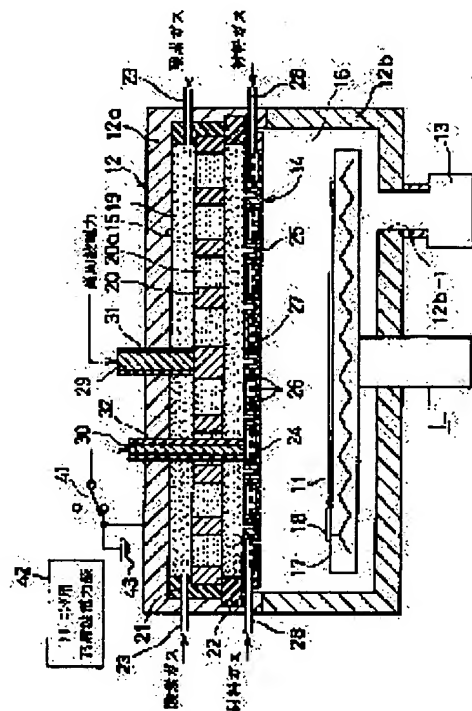
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(54) CVD DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To suppress the generation of particles and to prevent the incidence of ions on a substrate in the case a silicon oxide film, or the like, is formed on a large area substrate using silane or the like by CVD.

SOLUTION: In a vacuum vessel 12, plasma is generated to generate a radical, and a substrate is subjected to film forming treatment by this radical, silane or the like. The inside of the vacuum vessel is provided with a bulkhead part 14 separating the inside into two chambers of a plasma generating space 15 and a film formation treating space 16. On the bulkhead part, plural through holes 25 and diffusion holes 26 have been formed. An internal space 24 is fed with silane, or the like, and silane, or the like, is introduced into the film formation treating space through the diffusion holes 26. The radical generated on the plasma generating space is introduced through the through holes 25. The through holes 25 satisfy the condition of  $uL/D > 1$  in the case the gas flow rate in the through holes is defined as (u), the substantial length of the holes as L, and the diffusion coefficient of mutual gases as D.



LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

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DETAILED DESCRIPTION

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## [Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] this invention relates to the CVD system which was suitable for the membrane formation to a large-sized flat panel substrate especially about a CVD system.

[0002]

[Description of the Prior Art] As the production method of a large-sized liquid crystal display, the thing using elevated-temperature polysilicon contest type TFT (TFT) and the thing using low-temperature polysilicon contest type TFT are known conventionally. By the production method of using elevated-temperature polysilicon contest type TFT, in order to obtain a quality oxide film, the quartz substrate which bears the elevated temperature of 1000 degrees C or more was used. On the other hand, in production of low-temperature polysilicon contest type TFT, in order to use the usual glass substrate for TFT, it is necessary to form membranes in a low-temperature environment (for example, 400 degrees C). A special substrate does not need to be used for the method of manufacturing a liquid crystal display using low-temperature polysilicon contest type TFT, and it has the advantage that a setup of membrane formation conditions is easy, and is put in practical use in recent years, and the quantity of production is expanded.

[0003] By production of the liquid crystal display using low-temperature polysilicon contest type TFT, when forming a silicon oxide suitable as a gate insulator layer at low temperature, plasma CVD is used. In case a silicon oxide is formed by this plasma CVD, a silane, a tetrapod ethoxy silane (TEOS), etc. are used as typical material gas.

[0004] When forming a silicon oxide by CVD by plasma as material gas using a silane etc., it was made to form a silicon oxide on the front face of the substrate concerned by introducing material gas, oxygen, etc. into the front space of a substrate, generating plasma by material gas and the mixed gas of oxygen, and exposing a substrate to the plasma concerned according to conventional plasma CVD equipment. Thus, material gas consisted of conventional plasma CVD equipment so that it might supply directly into the plasma generated in plasma CVD equipment. For this reason, according to the composition of conventional plasma CVD equipment, the ion of a high energy carried out incidence to the membrane formation side of a substrate from the plasma which exists in the front space of a substrate, the damage was given to the silicon oxide, and the problem that a film property got worse existed. Since material gas was furthermore directly introduced into plasma, material gas and plasma reacted violently, particle occurred, and there was also a problem that the yield fell by this.

[0005] Then, in the former, in order to solve the above-mentioned problem, the plasma treatment equipment using the remote plasma method was proposed as an example. It constitutes from a remote plasma method so that the short charged particle of a life which is distant from the plasma production field in plasma equipment may disappear, and a substrate may be arranged to the field to which a radical with a comparatively long life stands high and exists and material gas may be supplied near the arrangement field of a substrate. The radical generated in the plasma field is diffused in the direction of

the field where the substrate has been arranged, and is supplied to the front space of the front face of a substrate. According to the plasma treatment equipment of this remote plasma method, the intense reaction of material gas and plasma is suppressed, the yield of particle is reduced, and it has the advantage that the incidence to the substrate of ion is also restricted further.

[0006] Moreover, plasma CVD equipment was proposed by JP,6-260434,A (patent No. 2601127) in the former. This plasma CVD equipment has parallel plate electrode structure. Plasma electric discharge is generated only between a RF electrode and a bipolar electrode by arranging a bipolar electrode, and dividing the space between a RF electrode and a substrate electrode-holder electrode between a RF electrode and a substrate electrode-holder electrode, and supplying RF power only between a RF electrode and a bipolar electrode. It is constituted so that the excitation active species generated in plasma electric discharge and ion may be introduced into the front space of a substrate through the breakthrough formed in the bipolar electrode. the diffusion board which a RF electrode is an electrode of the conventional shower head form, and has many holes -- each -- the gas for plasma production is introduced into plasma production space through a hole. Moreover, material gas is introduced into the front space of a substrate through the gas introduction space and the gas port which were formed in the gas introduction pipe and the bipolar electrode. The space between a RF electrode and a substrate electrode-holder electrode is divided with this plasma CVD equipment by the bipolar electrode, only the space between a RF electrode and a bipolar electrode is formed as plasma production space, and it has the composition from which the plasma production field was separated from the place on which the substrate was put. This plasma CVD equipment can be called modification of the equipment of a remote plasma method with parallel plate electrode structure.

[0007] Moreover, the plasma CVD equipment indicated by JP,5-21393,A exists conventionally. A plasma generating room and a substrate processing room are made from this CVD system inside the vacuum housing which forms an parallel monotonous type CVD system, and the composition which has arranged the mesh plate in the boundary section is shown.

[0008] Furthermore by the former, the plasma treatment equipment indicated by JP,8-167596,A exists. With this plasma treatment equipment, in a vacuum housing, it dissociates spatially and the plasma production room and the plasma treatment room are formed by the metal mesh plate and its supporter material. The charged particle in plasma is covered and it is made to make a neutral excited-atom kind etc. irradiate electrically to a processed material by making the diameter of two or more openings formed in the mesh plate below into the double precision of the debye length of the plasma generated at the plasma production room according to this plasma treatment equipment.

[0009]

[Problem(s) to be Solved by the Invention] In the case of the plasma treatment equipment of the above-mentioned remote plasma method, the plasma production field and the substrate arrangement field were left and formed through connection space, and there was a problem that membrane formation speed became low and a radical distribution near the front face of a substrate became bad since the radical generated in the place distant from the substrate was supplied to the front face of a substrate by the diffusion through connection space in it. Especially, since the radical distribution near the front face of a substrate was bad, the problem that it could not respond to the substrate of a large area used for a large-sized liquid crystal display was raised.

[0010] According to the plasma CVD equipment indicated by JP,6-260434,A (patent No. 2601127), since material gas is not supplied to the plasma production space between a RF electrode and a bipolar electrode, a chemical reaction does not occur around a RF electrode, but there is no deposition of the film in a RF electrode, and the advantage that generating of particle does not arise further is asserted. However, if it inquires strictly, about the size of the breakthrough formed in the bipolar electrode, there is no special consideration and material gas may carry out back-diffusion of gas to plasma production space. Therefore, material gas may enter into the bipolar-electrode bottom, and there is a possibility that a chemical reaction may occur around a RF electrode.

[0011] When based on the plasma CVD equipment indicated by JP,5-21393,A, the size of the breakthrough formed in the mesh plate is decided not to fulfill the conditions of this invention, material

gas may carry out back-diffusion of gas to plasma production space, and the same problem as the above-mentioned occurs.

[0012] In the case of the plasma treatment equipment indicated by JP,8-167596,A, it has the structure which bars movement of a charged particle in a plasma treatment room from a plasma production room. However, the structure which prevents the material gas introduced at the plasma treatment room so that plasma could not be touched carrying out back-diffusion of gas to a plasma production room through two or more openings of a mesh plate is not indicated. Therefore, material gas may enter to a plasma production room through a mesh plate, and there is a possibility that plasma and material gas may react.

[0013] It is production of the large-sized liquid crystal display which the purpose of this invention has in solving the above-mentioned problem, and used low-temperature polysilicon contest type TFT etc.

When forming a silicon oxide etc. to a large area substrate using material gas, such as a silane, based on CVD using plasma Contact in the plasma in the stage before forming membranes, and material gas is lost as much as possible on equipment structure. Generating of particle is fully suppressed, and the ion incidence on the front face of a substrate is prevented, a radical distribution near the membrane formation side of a substrate is further made good, and it is in offering the CVD system which can be used effective in the membrane formation to a large area substrate.

[0014]

[Means for Solving the Problem and its Function] The CVD system concerning this invention is constituted as follows in order to attain the above-mentioned purpose.

[0015] This CVD system is equipment which generates plasma within a vacuum housing, is made to generate active species (radical), and performs membrane formation processing to a substrate by this active species and material gas. The conductive septum section which isolates the interior of a vacuum housing to a bilocular is prepared in a vacuum housing. The interior of one loculus is formed between these two rooms as plasma production space where the RF electrode has been arranged, and the interior of the loculus of another side is formed as membrane formation processing space where the substrate maintenance mechanism in which a substrate is carried has been arranged. Furthermore, two or more breakthroughs which make plasma production space and membrane formation processing space lead are formed in this septum section. membrane formation processing space and diffusion of plurality that the septum section is further isolated [ and ] with plasma production space -- it has the building envelope which leads through the hole diffusion of plurality [ gas / material / which material gas was supplied to this building envelope from the exterior, and was supplied to the building envelope ] -- it is introduced into the above-mentioned membrane formation processing space through a hole The active species generated in plasma production space is introduced into membrane formation processing space through two or more breakthroughs formed in the septum section. the above-mentioned breakthrough or diffusion -- as following, the sizes (length, path, etc.) of a hole are designed so that specific conditions may be fulfilled

[0016] two or more breakthroughs formed in the septum section in the above-mentioned CVD system -- a hole -- the conditions of  $uL/D > 1$  are fulfilled when setting [ the gas flow rate inside ] L and a mutual gaseous diffusion coefficient (mutual gaseous diffusion coefficient of two sorts of gas of the both sides of a hole) to D for the length of u and a substantial hole moreover, two or more diffusion formed in the low wall of the septum section -- it is desirable to be formed so that the conditions same also about a hole as the above may be fulfilled

[0017] As the above-mentioned conditions which the breakthrough formed in the septum section fulfills, it lets these holes pass, and when material gas assumes [ the gas of plasma production space ] moving to an opposite side, respectively by diffusion as a mass transfer flow, it is set up so that the movement magnitude by diffusion may be restricted.

[0018] In the above-mentioned CVD system, preferably, material gas is diffused uniformly, and even if few, the diffusion structure of a bilayer is prepared in the building envelope at the septum section.

[0019] By isolating the building envelope of the vacuum housing which is a processing room in the septum section, it separates into the space and the membrane-formation processing space which generate plasma, and the composition in which the processing front face of the substrate arranged in membrane-

formation processing space is not exposed to plasma is adopted in the above-mentioned CVD system in the composition which generates plasma using oxygen gas and deposits a film on the surface of a substrate using material gas, such as a silane. Moreover, since it is isolated by the septum section, it is fully restricted that the material gas introduced into membrane formation processing space moves to a plasma production space side. Since two or more breakthroughs are formed in the septum section, although the plasma production space and membrane formation processing space of both sides of the septum section are actually connected through the breakthrough, since the size of a breakthrough is formed so that the conditions like the above-mentioned may be fulfilled, it is prevented that the material gas introduced into membrane formation processing space carries out back-diffusion of gas to a plasma production space side.

[0020] In membrane formation of a substrate, plasma is generated by oxygen gas in plasma production space, the radical (active species of oxygen gas) generated with plasma, the silane which is material gas are led to the membrane formation processing space where the substrate has been arranged, and a film is attached on the surface of a substrate by operation of CVD. It is the silicon oxide made from production of the liquid crystal display using low-temperature polysilicon contest type TFT as a gate insulator layer at low temperature as a membranous example. By preparing the septum section which has a hole, the building envelope of a vacuum housing is isolated in plasma production space and membrane formation processing space. two or more breakthroughs and diffusion -- the building envelope formed in septum circles, and the above-mentioned diffusion, while avoiding the field where plasma is generated in a silane etc. using a hole and introducing into the membrane formation processing space of the front face of a substrate directly The radical generated in plasma production space was introduced into membrane formation processing space through the above-mentioned breakthrough formed in the septum section. By setting up the size of the further above-mentioned breakthrough so that the above-mentioned specific conditions may be fulfilled, it has prevented preventing that material gas, such as a silane, is spread in a plasma production space side as much as possible, and a silane etc. touching plasma with it. It can prevent by this that plasma is directly mixed with a silane etc., and the conventional fault is canceled.

→ [0021] In the above-mentioned CVD system, it is characterized by connecting with the RF electric supply section which supplies the RF power for cleaning, and for the septum section supplying RF power to the septum section timely, and generating the plasma for cleaning in membrane formation processing space. In the above-mentioned CVD system, a RF electrode is arranged in the center of a simultaneously of the locus which form plasma production space, and it is constituted so that plasma may be generated between a RF electrode and the vacuum housing upper surface section and between a RF electrode and the septum section. The plasma production room which can seal the plasma generated except for the breakthrough of the septum section by this composition by using a part of vacuum housing and the conductive septum section as an electrode can be made. In the above-mentioned CVD system, a RF electrode can be prepared in the top position of plasma production space, and it can also constitute so that plasma electric discharge may be generated between a RF electrode and the septum section. This is the modification of electrode structure and can make the plasma production room sealed except for the breakthrough of the septum section using the septum section.

[0022]

[Embodiments of the Invention] Below, the suitable operation gestalt of this invention is explained based on an accompanying drawing.

[0023] The 1st operation gestalt of the CVD system which starts this invention with reference to drawing 1 and drawing 2 is explained. In drawing 1, by this CVD system, a silane is preferably used as material gas and a silicon oxide is formed as a gate insulator layer on the upper surface of the usual glass substrate 11 for TFT. In case the container 12 of a CVD system performs membrane formation processing, it is a vacuum housing by which the interior is held by the exhaust air mechanism 13 at a desired vacua. The exhaust air mechanism 13 is connected to exhaust air port 12b-1 formed in the vacuum housing 12.

[0024] The septum section 14 made from the conductive member is formed in the interior of a vacuum housing 12 in the level state, and the flat-surface configuration is arranged so that the circular septum

section 14 may be suppressed on the inferior surface of tongue of the insulating member 22 with the annular periphery section and a sealing state may be formed. The interior of a vacuum housing 12 is isolated by the septum section 14 at two up-and-down loculus. Upper loculus form the plasma production space 15, and lower loculus form the membrane formation processing space 16. The septum section 14 has desired specific thickness, and, on the whole, has a plate-like gestalt, and has a flat-surface configuration further similar to the horizontal section configuration of a vacuum housing 12. The building envelope 24 is formed in the septum section 14.

[0025] The above-mentioned glass substrate 11 is arranged on the substrate maintenance mechanism 17 prepared in the membrane formation processing space 16. The glass substrate 11 is arranged so that it may be substantially parallel to the septum section 14 and the membrane formation side (upper surface) may counter the inferior surface of tongue of the septum section 14. The potential of the substrate maintenance mechanism 17 is held at the grounding potential which is the same potential as a vacuum housing 12. Furthermore, the heater 18 is formed in the interior of the substrate maintenance mechanism 17. The temperature of a glass substrate 11 is held at this heater 18 at predetermined temperature.

[0026] The structure of a vacuum housing 12 is explained. A vacuum housing 12 consists of upper container 12a which forms the plasma production space 15, and lower container 12b which forms the membrane formation processing space 16 from a viewpoint which makes the assembly nature good. When making a vacuum housing 12 combining upper container 12a and lower container 12b, the septum section 14 is formed in the position between both. When the periphery section forms an electrode 20 so that it may mention later, as the isolation section 14 contacts the insulating member 22 of the bottom of the annular insulating member 21 and 22 interposed between upper container 12a, it is attached in it. Of this, the plasma production space 15 and the membrane formation processing space 16 which were isolated are formed in septum section 14 a top and the bottom. The plasma production space 15 is formed of the septum section 14 and upper container 12a. The field where plasma 19 is generated in the plasma production space 15 is formed from the above-mentioned septum section 14, upper container 12a, and the electrode (RF electrode) 20 of the tabular arranged mostly at a mid gear. two or more holes [ electrode / 20 ] -- 20a is formed The septum section 14 and an electrode 20 are supported and fixed by two annular insulating member 21 and 22 prepared in accordance with the flank inside of upper container 12a. The introductory pipe 23 which introduces oxygen gas is formed in the plasma production space 15 from the outside at the annular insulating member 21. The introductory pipe 23 is connected to the oxygen gas source of supply (not shown) through the mass-flow controller (not shown) which performs control of flow.

[0027] Although the interior of a vacuum housing 12 is isolated by the septum section 14 in the plasma production space 15 and the membrane formation processing space 16, it is dispersedly formed in the state where two or more breakthroughs 25 which fulfill predetermined conditions penetrate a building envelope 24, and the plasma production space 15 and the membrane formation processing space 16 are connected with the septum section 14 through these breakthroughs 25. Moreover, the building envelope 24 formed in the septum section 14 is the space for distributing material gas and supplying the membrane formation processing space 16 uniformly. two or more diffusion which furthermore supplies material gas to the membrane formation processing space 16 at the low wall of the septum section 14 -- the hole 26 is formed the above-mentioned breakthrough 25 or diffusion -- the hole 26 is made so that the predetermined conditions mentioned later, respectively may be fulfilled Moreover, the introductory pipe 28 for introducing material gas is connected to the above-mentioned building envelope 24. The introductory pipe 28 is arranged so that it may connect from the side. moreover -- the inside of a building envelope 24 -- material gas -- diffusion -- homogeneity is supplied from a hole 26 -- as -- two or more holes -- the uniform board 27 punched so that it might have 27a is formed almost horizontally As shown in drawing 2, the building envelope 24 of the septum section 14 is divided into two up-and-down space portions 24a and 24b with the uniform board 27. the material gas introduced into a building envelope 24 in the introductory pipe 28 is introduced into upper space 24a -- having -- the hole of the uniform board 27 -- 27a -- passing -- lower space 24b -- resulting -- further -- diffusion -- it will be spread to the membrane formation processing space 16 through a hole 26 Based on the above structure,

it becomes possible to supply material gas uniformly over the whole membrane formation processing space 16.

[0028] a part of septum section 14 is expanded, and drawing 2 shows -- having -- a breakthrough 25 and diffusion -- the important section of a hole 26 and the uniform board 27 is expanded, and is shown A breakthrough 25 has a path with the big plasma production space 15 side as an example, and the membrane formation processing space 16 side is made from the rat tail and the small path.

[0029] The power introduction rod 29 connected to the electrode 20 and the power introduction rod 30 connected to the septum section 14 are formed in the ceiling section of upper container 12a. Electric power is supplied to the RF power for electric discharge by the electrode 20 with the power introduction rod 29. An electrode 20 functions as a RF electrode. The <sup>over side</sup> heel of the power introduction rod 30 is connected to RF generator 42 for cleaning, or an earth terminal 43 through a changeover switch 41.

When forming membranes by plasma, a changeover switch 41 is connected to an earth terminal 43, and the septum section 14 is held at grounding potential. Moreover, a changeover switch 41 is connected to RF generator 42 for cleaning to timely timing so that it may mention later, and it cleans by supplying electric power in the RF power for cleaning to the septum section 14. In addition, an earth terminal 43 is connected also to upper container 12a of a vacuum housing 12, and upper container 12a is also held at grounding potential. The power introduction rods 29 and 30 are covered by each with insulators 31 and 32, and the insulation with other metal parts is achieved.

[0030] The membrane formation method by the CVD system constituted as mentioned above is explained. A glass substrate 11 is carried in to the interior of a vacuum housing 12 by the carrier robot, which is not illustrated, and is arranged on the substrate maintenance mechanism 17. The interior of a vacuum housing 12 is exhausted and decompressed by the exhaust air mechanism 13, and is held at a predetermined vacua. Next, oxygen gas is introduced into the plasma production space 15 of a vacuum housing 12 through the introductory pipe 23. At this time, the flow rate of oxygen gas is controlled by the external mass-flow controller. The rate of flow (u) of oxygen is searched for using a formula (1) and (2) from the flow rate (QO2) of oxygen gas, a pressure (PO2), and temperature (T).

[0031]

[Equation 1]

$$Q_{O_2} = \rho_{O_2} u A \quad (1)$$

$$P_{O_2} = \frac{\rho_{O_2} R T}{M} \quad (2)$$

ここで、 $\rho_{O_2}$  : 酸素ガスの密度

M : 酸素分子量

R : 普遍ガス定数

T : 絶対温度で表わした隔壁部 14 の温度

A : 隔壁部 14 に形成された貫通孔 25 の総断面積

u : 貫通孔 25 を流れる酸素ガスの流速

[0032] On the other hand, the silane which is material gas is introduced into the building envelope 24 of the septum section 14 through the introductory pipe 28. a silane is first introduced into top partial 24a of a building envelope 24, and is equalized with the uniform board 27 -- having -- bottom partial 24b -- moving -- a degree -- diffusion -- it is introduced, without contacting plasma directly to the membrane formation processing space 16 through a hole 26 Since energization is performed at the heater 18, the substrate maintenance mechanism 17 prepared in the membrane formation processing space 16 is held beforehand at predetermined temperature.

[0033] In the above-mentioned state, RF power is supplied through the power introduction rod 29 to an electrode 20. By this RF power, electric discharge arises and the oxygen plasma 19 is generated around an electrode 20 in the plasma production space 15. By generating the oxygen plasma 19, the radical

(excitation active species) which is a neutral excitation kind is generated.

[0034] When forming membranes on the front face of a substrate 11, the building envelope of a vacuum housing 12 In the composition isolated in the septum section 14 formed by the electrical conducting material in the plasma production space 15 and the membrane formation processing space 16 the silane which oxygen gas is introduced in the plasma production space 15, and RF power is supplied to an electrode 20, and the oxygen plasma 19 is generated, and is material gas in another side and the membrane formation processing space 16 -- the building envelope 24 of the septum section 14, and diffusion -- it is directly introduced through a hole 26 Although the neutral radical which has a longevity life among the oxygen plasma 19 generated in the plasma production space 15 is introduced into the membrane formation processing space 16 through two or more breakthroughs 25 of the septum section 14, many of charged particles become extinct. a silane -- the building envelope 24 of the septum section 14, and diffusion -- it is directly introduced into the membrane formation processing space 16 through a hole 26 Moreover, carrying out back-diffusion of gas of the silane directly introduced into the membrane formation processing space 16 to a plasma production space side based on the gestalt which a breakthrough 25 has is suppressed. Thus, when introducing into the membrane formation processing space 16 the silane which is material gas, it is prevented that a silane does not touch the oxygen plasma 19 directly and a silane and oxygen plasma react violently. In this way, a silicon oxide is formed by the front face of the substrate 11 which countered the inferior surface of tongue of the septum section 14, and has been arranged in the membrane formation processing space 16.

[0035] In the above-mentioned structure, gestalten, such as a size of two or more breakthroughs 25 of the septum section 14, make the oxygen gas in the plasma production space 15 the mass transfer flow in a breakthrough, and when the silane in the membrane formation processing space 16 assumes performing spreading diffusion to the space of an opposite side through a breakthrough 25, it is decided that the movement magnitude by the diffusion is restricted to the request range. That is, when setting the mutual gaseous diffusion coefficient to  $D$  about the oxygen gas and the silane which flow the breakthrough 25 in case the temperature of the septum section 14 is  $T$ , for example and setting the length (the characteristic length of a breakthrough) of the diameter portion of the minimum of a breakthrough 25 to  $L$ , it is decided using a gas flow rate (it considers as the rate of flow  $u$  of gas) that the relation of  $uL/D > 1$  is filled. the diffusion to which the conditions about the gestalt of the above breakthrough were preferably formed in the septum section 14 -- it is similarly applied about a hole 26

[0036] Above-mentioned  $uL/D > 1$  The relation of 1 is drawn as follows. For example, the following formula (3) is materialized using silane gas density ( $\rho_{\text{SiH}_4}$ ), the diffusion rate of flow ( $u_{\text{SiH}_4}$ ), and a mutual gaseous diffusion coefficient ( $D_{\text{SiH}_4\text{-O}_2}$ ) about the relation of the oxygen and the silane which move a breakthrough 25. If the characteristic length of a breakthrough is set to  $L$ , a formula (3) can resemble a formula (4). As a result of comparing the both sides of a formula (4), the diffusion rate of flow ( $u_{\text{SiH}_4}$ ) of a silane is expressed with  $-D_{\text{SiH}_4\text{-O}_2} / L$ . Therefore, when the above-mentioned formula (1) and the oxygen rate of flow acquired from (2) are set to  $u$  and the diffusion rate of flow of a silane is set to  $-D_{\text{SiH}_4\text{-O}_2} / L$  The ratio of the absolute value of these two rates of flow, i.e.,  $|-u/(-D_{\text{SiH}_4\text{-O}_2} / L)| = uL/D_{\text{SiH}_4\text{-O}_2}$ , a value is the ratio of an oxygen mass transfer rate and a silane diffusion rate. this ratio --  $uL/D_{\text{SiH}_4\text{-O}_2}$  Carrying out to one or more means that the flow rate by the convection current is large as compared with the flow rate of diffusion. Namely,  $uL/D_{\text{SiH}_4\text{-O}_2}$  Making a value or more into one means that there is little diffusion influence of a silane.

[0037]

$\rho_{\text{SiH}_4} u_{\text{SiH}_4} = -D_{\text{SiH}_4\text{-O}_2} \text{grad} \rho_{\text{SiH}_4}$  (3)

$\rho_{\text{SiH}_4} u_{\text{SiH}_4} = -D_{\text{SiH}_4\text{-O}_2} \rho_{\text{SiH}_4} / L$  (4)

[0038] Next, a concrete example is explained. If the pressure of 500sccm(s) and the membrane formation processing space 16 is set [ the diameter of the breakthrough 25 formed in 300 degrees C and the septum section 14 in the temperature of the septum section 14 / the length ( $L$ ) of a portion with 0.5mm and a diameter of 0.5mm / the total of 3mm and a breakthrough 25 ] to 100Pa for the quantity of gas flow of 500 pieces and oxygen gas, the value of the above-mentioned formula will be set to 11. In such a case, since the influence of a flow is large enough as compared with diffusion of silane gas, it

decreases that the silane gas to the plasma production space 15 is spread.

[0039] the breakthrough 25 in which the plasma production space 15 and the membrane formation processing space 16 have the above-mentioned property as mentioned above, and diffusion -- since it is divided and isolated so that a hole 26 may serve as locus closed in the formed septum section 14, respectively, the silane directly introduced into the membrane formation processing space 16 and oxygen plasma hardly contact. Therefore, it is conventionally prevented like equipment that a silane and oxygen plasma react violently.

→ [0040] Next, cleaning of the membrane formation processing space 16 is explained. According to the CVD system of this operation gestalt, since plasma is not fully spread in the membrane formation processing space 16, cleaning to the membrane formation processing space 16 produces the problem of being difficult. Then, it is NF3 in the membrane formation processing space 16 like the above-mentioned by connecting the power introduction rod 30 to the septum section 14 electrically, connecting a changeover switch 41 to the RF power-source 42 side for cleaning, and supplying RF power from the RF power source 42 for cleaning. Plasma was generated. The interior of the membrane formation processing space 16 is cleaned with the generated plasma. Moreover, when not making an issue of cleaning speed, electric discharge in the membrane formation processing space 16 is not performed, but it is NF3 to the plasma production space 15. Plasma can be generated and it can also clean using the fluorine radical diffused to the membrane formation processing space 16 through the breakthrough 25 of the septum section 14. In that case, a changeover switch 41 is connected to an earth terminal 43, and let the septum section 14 be grounding potential. Timing which performs this cleaning is performed to timely based on the criteria for every predetermined time decided beforehand and every predetermined substrate number of sheets.

[0041] Next, the 2nd operation gestalt of the CVD system which starts this invention with reference to drawing 3 is explained. In drawing 3, the same sign is substantially given to the same element with the element explained by drawing 1, and it omits repeating detailed explanation here. The characteristic composition of this operation gestalt forms the disc-like insulating member 33 inside the ceiling section of upper container 12a, and arranged the electrode 20 to the down side. an electrode 20 -- the above -- a hole -- 20a is not formed but has the gestalt of a single the board of a \*\* The plasma production space 15 15 by parallel monotonous type electrode structure is formed by the electrode 20 and the septum section 14. Other composition is substantially [ as the composition of the 1st operation gestalt ] the same. Furthermore, the operation by the CVD system by the 2nd operation gestalt and an effect are the same as the above-mentioned 1st operation gestalt.

[0042] Although the above-mentioned operation form explained the example of a silane as material gas, it is not limited to this but, of course, other-materials gas, such as TEOS, can be used. Moreover, it is applicable not only to a silicon oxide but other membrane formation, such as a silicon nitride. When material gas touches plasma, the theoretic idea of this invention can be applied to all processings to which it poses a problem that particle occurs and that ion carries out incidence to a substrate, and can be applied to direction etching, such as membrane formation and surface treatment, etc. With the further above-mentioned operation form, although the septum section has dual structure, of course, it is made to multilayer structure if needed.

[0043]

[Effect of the Invention] When using material gas, such as a silane, for a large area substrate by plasma CVD by the above explanation according to this invention so that clearly, and forming a silicon oxide etc. The interior of a vacuum housing is isolated to plasma production space and membrane formation processing space by preparing the septum section in which the hole was formed. two or more breakthroughs which fulfill predetermined conditions, or diffusion -- the active species generated in plasma production space is introduced into membrane formation processing space through the breakthrough of the septum section -- having -- material gas -- the building envelope of the septum section, and diffusion, since it was made to introduce into membrane formation processing space directly, without touching plasma through a hole. The intense chemical reaction between material gas and plasma can be prevented, consequently generating of particle can be suppressed and the ion

incidence to a substrate can be prevented.

[0044] Moreover, by two or more breakthroughs which could introduce material gas uniformly and were formed in the septum section, the radical of oxygen gas can also be uniformly supplied to membrane formation processing space, the distribution of the radical near the front face of a substrate, a silane, etc. can be made good by this, and membrane formation to a large area substrate can be performed effectively.

[0045] Moreover, the power introduction rod for cleaning is attached to the septum section, and since it enabled it to clean by supplying power, though the plasma production space and membrane formation processing space which were isolated in the septum section are formed in a vacuum housing, the cleanliness of membrane formation processing space is appropriately maintainable.

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DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]

[Drawing 1] It is drawing of longitudinal section showing the composition of the 1st operation gestalt of this invention.

[Drawing 2] It is the expanded sectional view of various kinds of holes formed in the septum section.

[Drawing 3] It is drawing of longitudinal section showing the composition of the 2nd operation gestalt of this invention.

[Description of Notations]

11 Glass Substrate

12 Vacuum Housing

14 Septum Section

15 Plasma Production Space

16 Membrane Formation Processing Space

17 Substrate Maintenance Mechanism

20 Electrode

24 Building Envelope

25 Breakthrough

26 Diffusion -- Hole

27 Uniform Board

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## DETAILED DESCRIPTION

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### [Detailed Description of the Invention]

[0001]

[Industrial Application] It is plasma treatment equipment by the remote plasma method for separating plasma gas and reactant gas, and this invention is used especially for the plasma CVD and plasma etching of a large area, and is suitable equipment.

[0002]

[Description of the Prior Art] The remote plasma (Remote Plasma) method is learned as the plasma treatment method of reducing the damage by plasma. This remote plasma method is a method by which the damage of plasma is isolated by the substrate which in CVD should separate a plasma generating room and a film deposition room, should pull out plasma on the boundary of each of those loculus, and should decompose the gas for membrane formation, and a film should deposit.

[0003] Moreover, as structure of separating a plasma generating room and a substrate processing room, efficient consumer response (electron cyclotron resonance) plasma treatment equipment which is indicated by JP,1-168027,A, for example is known.

[0004]

[Problem(s) to be Solved by the Invention] In the CVD system by the conventional remote plasma method, generally, a plasma generating room is made small and, moreover, plasma decomposes the gas for membrane formation to a wafer only at one place. For this reason, it was made difficult to form a uniform film to the wafer of the large area like 8 inches or 12 inches.

[0005] Although it considers as the structure of preparing the position of a gas feed system near [ both ] the substrate near the drawer board of plasma and equalization of the plasma treatment is attained with the technology of the above-mentioned official report, the plasma generated at the plasma generating room will be pulled out at a substrate processing room, and since direct action of the plasma is carried out to a substrate, the damage by the plasma poses a problem.

[0006] Then, this invention aims at offer of plasma treatment equipment which performs uniform plasma treatment to the substrate of a large area as the reduction effect of the damage by remote plasma was maintained.

[0007]

[Means for Solving the Problem] In order to solve an above-mentioned technical technical problem, the plasma treatment equipment of this invention is characterized by having the mesh plate for plasma separation with which two or more holes were prepared, and preparing a gas supply mouth near the hole of this mesh plate between a plasma generating room and a substrate processing room.

[0008] this gas supply mouth -- a mesh plate -- each -- a hole may be alike, respectively, it may prepare so that it may correspond, and you may prepare so that opening may be carried out toward a center from the circumference near the substrate processing room side side of a mesh plate for example, the former - - each -- what resembles a hole, respectively and corresponds to it -- the middle of a hole -- this -- the thing made to draw from the wall of a hole -- each -- the hole of what cut and lacked the edge by the side of the substrate processing room side of a hole, and the field by the side of the substrate processing room

of a mesh plate -- what has a gas supply mouth is mentioned to the field between comrades each -- the number of a hole and gas supply mouths -- 1 to 1 [ for example, ] -- many -- although it shall correspond to pair 1, it is not limited to this, but it may correspond with the group of a certain hole, or may have regularity or a strange good number of gas supply mouths for every hole Moreover, especially the configuration of a gas supply mouth may not be limited, but the positions of a gas supply mouth may also be movement and the thing which can be adjusted.

[0009] Made to parallel monotonous type structure, in order that especially the plasma treatment equipment of this invention may process the processed substrate of a large area, a mesh plate serves as one side of the electrode of the couple which counters in this case. As an example of the plasma treatment in the equipment of this invention, plasma CVD, the surface treatment by plasma etching or plasma, etc. are mentioned.

[0010]

[Function] With the plasma treatment equipment of this invention, since the mesh plate for plasma separation is used, plasma is not pulled out toward the processed substrate of a substrate processing room, and the damage of plasma is lost to a processed substrate. Moreover, by using a mesh plate, with two or more holes, the field where plasma and the gas for processing react will distribute in a plate side, and the uniform film formation and uniform etching of it are attained also to the substrate of a large area. By arranging a gas supply mouth near the hole, the reaction of the gas for processing will be made near the hole, respectively, and efficient plasma treatment is made.

[0011]

[Example] The suitable example of this invention is explained referring to a drawing.

[0012] The outline structure this example of plasma CVD equipment is plasma CVD equipment, and shows the structure of the outline to drawing 1 . This plasma CVD equipment is an parallel monotonous type CVD system. Equipment is the mesh plate 1 with which it has the plasma generating room 22 and the substrate processing room 21 fundamentally, and being allotted on the boundary of both [ these ] the locus 22 and 21 for plasma separation has two or more holes 4.

[0013] the outer wall of metal [ outline / of equipment ] -- a member 8 isolates the lower part of the pars basilaris ossis occipitalis of the equipment concerned, and a flank with the open air, and the glass vitreous humour 10 which is an insulator isolates the upper part side of an equipment side attachment wall with the open air The metal up electrode 11 is attached in the upper part of the equipment concerned. The plasma generating room 22 and the substrate processing room 21 are established in the interior of these outside wall material 8, a vitreous humour 10, and the up electrode 11. The circumferential side and the vitreous humour 10 of the outside wall material 8 are a cylinder-like, and the up electrode 11 is the approximate circle board-like here.

[0014] The plasma generating room 22 is formed between the up electrode 11 and the mesh plate 1, and plasma generates it here. It connects with the core of the up electrode 11 through the flange pedestal 15 made from the ceramic for the insulation with the introductory electric pipe 16 of the gas for plasma generating, and this introductory pipe 16 follows the branch pipe 13 which branched inside the up electrode 11. The inferior surface of tongue of the up electrode 11 is faced the point at which the branch pipe 13 branched, and let it be the derivation mouth 14 of the gas for plasma generating, respectively. The derivation mouths 14 of these gas are scattered at a predetermined interval on the inferior surface of tongue of the up electrode 11 so that the gas of abbreviation homogeneity may be distributed in the plasma generating room 22. The RF power supply 12 is electrically connected to the metal up electrode 11, and RF signal is supplied at the time of plasma generating. Besides, the section electrode 11 counters with the mesh plate 1 mentioned later at the plasma generating room 22, and let the equipment concerned be an parallel monotonous type.

[0015] Next, the substrate processing room 21 is the outside wall material 8 interior, and is downward space from the mesh plate 1. the outer wall of the pars basilaris ossis occipitalis of this substrate processing room 21 -- from a member 8, it is formed so that a susceptor 5 may project, and the heater 6 for heating of the substrate 20 by which plasma treatment should be carried out is built in this susceptor 5 This heater 6 is controlled by the power supply 7 of the equipment exterior. The gas exhaust pipe 9

connected to the drainage pump which is not illustrated is connected to the pars basilaris ossis occipitalis of the substrate processing room 21, and gas is discharged from this gas exhaust pipe 9. Moreover, the outside wall material 8 and a susceptor 5 are grounded.

[0016] The structure mesh plate 1 of a mesh plate is a metal plate for separating the above-mentioned substrate processing room 21 and the above-mentioned plasma generating room 22, the flat-surface configuration is made into a configuration as typically shown in drawing 2, and circumference 1c of the mesh plate 1 is made circular. Two or more holes 4 are formed in this disc-like mesh plate 1, and these holes 4 are arranged in the shape of a matrix at intervals of about 5mm. each -- let size of a hole 4 be the diameter of about 3mm, respectively -- having -- this example -- each -- although the size of a hole is the same size, it is good also as size of a hole which is different on the inside and the outside The mesh plate rear-face board 18 is formed in the field by the side of the susceptor of this mesh plate 1. This mesh plate rear-face board 18 is a metal plate which prepared the hole of a diameter R in the center, and let the crevice between the edge which constitutes this hole, and the mesh plate 1 be the gas supply mouth 2. That is, the gas supply mouth 2 has a cylindrical side configuration. The gas supply mouth 2 is a mouth for introducing reactant gas in the substrate processing room 21, from the structure of such a mesh plate 1 and the mesh plate rear-face board 18, the gas supply mouth 2 will be arranged near the hole 4, and reactant gas will be certainly sent toward the hole 4 of the mesh plate 1. the gas supply mouth 2 -- the portion of circumference 1c of the mesh plate 1 -- perpendicular -- an outer wall -- two or more metallic pipes 3 which extend toward the pars basilaris ossis occipitalis of a member 8, and support the mesh plate 1 are followed This metallic pipe 3 has an about 1/8mm diameter, and reactant gas is supplied to these metallic pipes 3 in the equipment exterior. These metallic pipes 3 are grounded and also let the mesh plate 1 be grounding potential simultaneously. Electrodes counter at the plasma generating room 22, and the plasma CVD equipment of this example turns into parallel monotonous type equipment.

[0017] The example of a membrane formation experiment using the equipment of this example, next the example of deposition of the silicon oxide (SiO<sub>2</sub> film) using the plasma CVD equipment of an above-mentioned this example are explained based on the example of an experiment.

[0018] After exhausting gas from the gas exhaust pipe 9 first and adjusting the pressure inside equipment to about 600 mTorr, from the derivation mouth 14 of the up electrode 11, N<sub>2</sub> O gas was passed by flow rate 100sccm, and the silane (SiH<sub>4</sub>) gas diluted with the argon 10% was passed 20 sccms from the metallic pipe 3. Next, the signal of RF power 10W was supplied to the up electrode 11 from the RF power supply 12 on the frequency of 13.56MHz. Stable electric discharge of N<sub>2</sub> O plasma was observed in the plasma generating room 22 of the upper part of the mesh plate 1 by the signal supply from this RF power supply 12, and electric discharge did not occur by it at the substrate processing room 21 of the lower part of the mesh plate 1. N<sub>2</sub> O plasma -- the mesh plate 1 -- each -- it reacted with the silane gas from the gas supply mouth 2 in the portion of a hole 4, and the silicon oxide accumulated on the front face of the substrate 20 laid on the susceptor 5 of the lower part of the mesh plate 1 as the result

[0019] When it investigated about the silicon oxide deposited on this substrate 20 here and the substrate temperature by heating of a heater 6 was about 250 degrees C, the rate of sedimentation was 170A/min, and the refractive index of a silicon oxide was 1.47.

[0020] Next, in order to carry out comparison contrast with this experiment, it experimented also about the example which removed the mesh plate 1. When N<sub>2</sub> O gas was similarly supplied from the up electrode 11 and silane gas was introduced into the reaction chamber, it was 150A of the rate of sedimentation, and min, and the refractive index of a silicon oxide was 1.46.

[0021] If two experiments are compared, the rate of sedimentation and the refractive index are equivalent, therefore it is shown by by using the mesh plate 1 that the efficiency of gas decomposition is not falling at all. And in the example which used the mesh plate 1 for plasma separation, since the damage by plasma was reduced, it was shown by production of the following TFT (TFT) device that the outstanding device of a property can be manufactured. For example, in the example which used the plasma CVD equipment of this example for film formation of the gate oxide film of TFT which used the polysilicon contest layer for the channel layer, when the gate oxide film of 1000A thickness was formed

on the polysilicon contest layer, it was shown in the experiment that drain current became large also 30 times compared with the former. This can be concluded to be because for the interface of a silicon film and a silicon oxide to show the good electrical property, and to be because for the damage of plasma to be eased.

[0022] What is necessary is just to adopt as the example pan of structure of other mesh plates the mesh plate shown in drawing 3 or drawing 4 in a cross section for the plasma CVD of a large area. In addition, the flat-surface configuration of drawing 3 and the mesh plate of 4 is constituted as shown in drawing 2.

[0023] the cross section in two or more holes 34 with which drawing 3 penetrates the front reverse side of the mesh plate 31 -- it is -- each -- a hole 34 is a cylinder-like bore, respectively It is arranged in the shape of a matrix like [ the hole 34 of this mesh plate 34 ] the mesh plate of drawing 2. As for this mesh plate 31, between surface 31a and rear-face 31b is made into the centrum 35 of conductance high in comparison, and reactant gas passes the centrum 35. each -- opening 32 is formed and let this opening 32 be a gas supply mouth at the rear-face 31b side of a hole 34 the reactant gas which this opening 32 is a configuration which goes around the side attachment wall of a hole 34, and was drawn from the opening 32 concerned -- the surface 31a side of the mesh plate 31 -- generating -- each -- it reacts with the plasma gas which passes a hole 34 here -- the reaction with plasma gas -- especially -- each -- the membrane formation matter will be formed, distributing on the whole plate as a result, since it happens every hole 34 Therefore, uniform membrane formation is realized by the large area.

[0024] drawing 4 is the example of the mesh plate 41 of further others, and penetrated surface 41a and rear-face 41b -- each -- it has opening 42 in the halfway of a hole 44 this mesh plate 41 -- also setting -- the mesh plate 31 of drawing 3 -- the same -- conductance with a high centrum 45 -- having -- reactant gas -- each -- it is uniformly sent to a hole 44 Therefore, a reaction is uniformly advanced over the whole plate and uniform membrane formation is made.

[0025] In addition, although the above-mentioned example explained plasma CVD equipment, the plasma treatment equipment of this invention may be other equipments, such as a plasma etching system. Moreover, neither various kinds of light nor the irradiation means of laser may be provided, and neither a configuration, nor size or a position of a hole or a gas supply mouth (opening) is limited, and can be designed if needed in the range which does not deviate from the summary of this invention.

[0026]

[Effect of the Invention] With the plasma treatment equipment of this invention, without reducing the reaction efficiency, since the mesh plate for plasma separation is arranged, separation of plasma will be possible and the damage of the plasma to a processed substrate will be reduced remarkably. this, simultaneously a mesh plate -- each -- with a hole, the place where plasma and reactant gas react will cover the whole plate, and it will distribute superficially, consequently a large area is covered, and uniform membrane formation and uniform etching are attained Especially this invention is used for manufacture of \*\*\*\*\* devices, such as TFT, and the improvement in a property of an epoch-making device is expected.

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DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]

[Drawing 1] The outline cross section showing the structure of the plasma CVD equipment of one example of the plasma treatment equipment of this invention

[Drawing 2] The typical plan of the mesh plate of the above-mentioned plasma CVD equipment

[Drawing 3] The typical cross section of other examples of a mesh plate of the above-mentioned plasma CVD equipment

[Drawing 4] The typical cross section of the example of a mesh plate of further others of the above-mentioned plasma CVD equipment

[Description of Notations]

1, 31, 41 -- Mesh plate

2 -- Gas supply mouth

3 -- Metallic pipe

4, 34, 44 -- Hole

5 -- Susceptor

11 -- Up electrode

20 -- Substrate

21 -- Substrate processing room

22 -- Plasma generating room

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[Translation done.]